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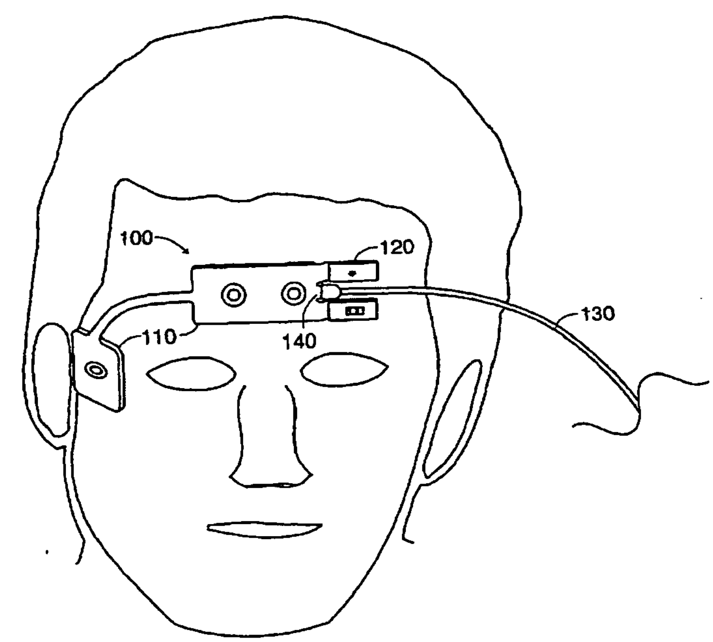
(54) Title: PHYSIOLOGICAL SENSOR COMBINATION



(57) Abstract: A physiological sensor combination has a flexible substrate configured to attach to a tissue site. Multiple sensors are disposed on the substrate, which generate physiological signals. Each of the signals is responsive to a different physiological parameter. Conductors are carried on the substrate and routed between the sensors and at least one connector. The connector is configured to communicate the physiological signals to at least one monitor, which derives measurements of the parameters.

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fold so that the circuit side is proximate the second side. Further, the emitter and the detector may be mounted to the a fold-over portion. The substrate may define at least one aperture configured so that the emitter and the detector each align with a corresponding aperture when the fold-over is in a folded position.

In another particular embodiment, the physiological sensor combination comprises a plurality of biopotential sensor pinouts corresponding to the electrodes, a plurality of optical sensor pinouts corresponding to the emitter and the detector, and a common connector extending from the substrate. The biopotential sensor pinouts and said optical sensor pinouts are each disposed on the common connector.

Another aspect of a physiological sensor combination is a substrate means for combining a first sensor and a second sensor, a connector means for communicating signals from the first sensor and the second sensor to at least one monitor, and an identifying means of conveying information about each of the first sensor and the second sensor to the monitor. The physiological sensor combination may further comprise a fold-over means for positioning sensor components so as to extend away from a tissue site. The physiological sensor combination may additionally comprise an aperture means for providing light communications between sensor components and the tissue site.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an illustration of a physiological sensor combination applied to a patient and having a patient cable connected near the patient's forehead;

FIG. **2** is an illustration of a physiological sensor combination applied to a patient and having a patient cable connected near the patient's temple;

FIGS. **3A-B** are perspective views of a circuit substrate and an assembled sensor, respectively, for a physiological sensor combination having a single-sided circuit substrate and a shared connector;

FIG. **4** is a schematic diagram of a physiological sensor combination showing the location of applied sensor components;

FIG. **5** is a layout diagram of a single-sided circuit for a physiological sensor combination;

FIG. **6** is a perspective view of a physiological sensor combination having a single-sided circuit substrate and dual connectors; and

FIG. **7** is a perspective view of a physiological sensor combination having a double-sided circuit substrate and dual connectors.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. **1-2** show a physiological sensor combination applied to a patient. FIGS. **3-5** illustrate a physiological sensor combination having a biopotential sensor and an optical sensor configured on a single-sided flexible circuit substrate with a shared patient cable connector. FIG. **6** illustrates a physiological sensor combination also having a biopotential sensor and an optical sensor configured on a single-sided flexible circuit substrate. The biopotential sensor and the optical sensor, however, each have separate patient cable

As shown in FIG. **3B**, the biopotential sensor **110** has an adhesive foam layer **310** disposed around the electrodes **410** on the circuit side **502**. The foam layer **310** has an adhesive for patient skin attachment and cushions the biopotential sensor **110** against the skin. Further, the foam layer **310** forms cavities around the electrodes **410** that are filled with a conductive gel for electrical communication between a tissue site and the electrodes **410**. Printed electrode indicators **370** facilitate sensor application on a tissue site. Electrodes printed on a substrate, an associated foam layer, and gel-filled foam cavities are described in detail in US Patent No. 6,032,064 entitled "Electrode Array System For Measuring Electrophysiological Signals," assigned to Aspect Medical Systems, Inc. and incorporated by reference herein. One of ordinary skill in the art will recognize that various electrode configurations may be utilized as the biopotential sensor **110**.

Also shown in FIG. **3B**, the optical sensor **120** has a face tape **330** and a base tape **340** that envelop the fold-over **540** along with the fold-over mounted components **420-440**. In one embodiment, the face tape **330** and base tape **340** attach together and to the fold-over **540** with PSA. Further, the base tape **340** has a backing (not shown) that is removed to expose an adhesive for skin attachment. The face tape **330** also secures the detector **430** within an optical cavity and cover **350**. A printed emitter indicator **390** facilitates sensor application on a tissue site. Emitters, detectors, optical cavities and corresponding covers are described in detail in US Patent No. 6,256,523, referenced above.

Further shown in FIG. **3B**, the physiological sensor combination **100** has a tab **320** that attaches to the stub **530** (FIG. 3A) to complete the connector **140**. In one embodiment, the attachment is accomplished with pressure sensitive adhesive (PSA) between the tab **320** and stub **530**. The tab **320** provides a stiffener for the pinouts **532** (FIG. **5**) and an insertion and locking mechanism for a mating patient cable connector, as described in US Patent No. 6,152,754 entitled "Circuit Board Based Cable Connector" and US Patent No. 6,280,213 entitled "Patient Cable Connector," each assigned to Masimo Corporation and incorporated by reference herein.

The physiological sensor combination **100** is described above with respect to a fold-over that positions the optical sensor components **420-440** so that they extend away from the tissue site. This advantageously allows a smooth surface to be positioned against the tissue site for patient comfort. In another embodiment, however, there is no fold-over **540** and the components **420-440** extend from the substrate toward the tissue site. In yet another embodiment, there is no fold-over and the components **420** are mounted on the substrate side opposite the conductors and utilize substrate feed-throughs to connect with the flex circuit traces **510**. Further, the fold-over **540** is described above as positioning the emitter **420** and detector **430** over substrate apertures **520** (FIG. **5**). In an alternative embodiment, the fold-over **540** is skewed so that the emitter **420** and detector **430** are positioned away from the substrate so that no apertures are necessary.

FIG. **4** illustrates a circuit diagram for a physiological sensor combination **100** having a biopotential sensor circuit **401** and an optical sensor circuit **402**. The biopotential sensor circuit **401** has an electrode

FIG. 5 illustrates a flexible circuit **500** for a physiological sensor combination **100**. The flexible circuit **500** has a substrate **504**, traces **510**, electrodes **410**, pinouts **530** and apertures **520**. Conductors are deposited and/or etched on a circuit side **502** of the substrate **504** in a pattern to form the traces **510**, electrodes **410** and pinouts **532**, as is well known in the art. In one embodiment, the substrate **504** is a flexible polyester film and the conductors are silver/silver-chloride. In another embodiment, the conductors are copper. The components **420-440** attach to the flexible circuit **500** and are electrically connected to the traces **510**, such as with solder. The fold-over **540** is configured so that the emitter **420** and detector **430** align with the corresponding apertures **520**.

FIG. 6 illustrates a physiological sensor combination **600** having a biopotential sensor **610** and an optical sensor **660**. The biopotential sensor **610** is configured as described with respect to FIGS. **3-5**, above, except that the physiological sensor combination **600** has a connector **620** that is dedicated to the biopotential sensor **610** rather than being shared with the optical sensor **660**. The optical sensor **660** also is configured as described with respect to FIGS. **3-5**, above, except that a connector **670** is dedicated to the optical sensor **660** rather than being shared with the biopotential sensor **610**. Further, the optical sensor **660** has a single fold-over (not visible) on which is mounted the emitter **420** (FIG. **4**) and detector **430** (FIG. **4**) rather than having a separate fold-over **540** (FIG. **3A**) for each.

FIG. 7 illustrates a physiological sensor combination **700** having a biopotential sensor **710** and an optical sensor **760**. The biopotential sensor **710** is configured as described with respect to FIG. **6**, above. The optical sensor **760** also is configured as described with respect to FIG. **6**, above, except that the flexible circuit **500** (FIG. **5**) is double-sided, i.e. the traces **510** (FIG. **5**) associated with the biopotential sensor **710** are on the side facing the patient's skin when applied, and the traces **510** (FIG. **5**) associated with the optical sensor **760** are on the side away from the patient's skin when applied. As a result, the connector **770** is dedicated to the optical sensor **760** and has pinouts **772** facing away from the patient's skin when applied. Further, the optical sensor **760** does not have a fold-over **540** (FIG. **3A**). Rather, the optical sensor components **420-440** (FIG. **4**) are mounted on the flexible circuit side away from the patient's skin.

A physiological sensor combination is described above with either a shared patient cable connector or a patient cable connector dedicated to each sensor. One of ordinary skill will recognize that either connector configuration will allow the sensor to communicate with a single monitor that analyzes and displays multiple physiological parameters or, alternatively, multiple monitors that are dedicated to analyzing only related physiological parameters, such as oxygen saturation and pulse rate.

The physiological sensor combination as described above can be cost effectively manufactured, advantageously allowing disposable use. One of ordinary skill in the art will recognize that, however, that the physiological sensor combination as disclosed herein can be similarly applied to construct a reusable sensor combination.

WHAT IS CLAIMED IS:

1. A physiological sensor combination comprising:

a flexible substrate configured to attach to a tissue site;

a plurality of sensors disposed on said substrate and adapted to provide a corresponding plurality of physiological signals, each of said signals responsive to at least one of a plurality of physiological parameters; and

a plurality of conductors disposed on said substrate between said sensors and at least one connector,

said at least one connector configured to communicate said signals to at least one monitor so as to derive a plurality of measurements of said parameters.

2. The physiological sensor combination according to claim 1 wherein said sensors comprise:

a plurality of electrodes disposed on said substrate, each of said electrodes adapted to be in electrical communication with said tissue site and electrically connected to at least one of said conductors; and

an emitter and a detector mounted to said substrate and electrically connected to at least one of said conductors, said emitter adapted to transmit light into said tissue site and said detector adapted to receive reflected light from said tissue site.

3. The physiological sensor combination according to claim 2 wherein:

said substrate has a first side adapted to face toward said tissue site and a second side adapted to face away from said tissue site;

said conductors and said electrodes disposed on said first side; and

said emitter and said detector mounted to said first side.

4. The physiological sensor combination according to claim 3 wherein said substrate comprises a fold-over portion having a circuit side corresponding to said first side, said fold-over portion adapted to fold so that said circuit side is proximate said second side.

5. The physiological sensor combination according to claim 4 wherein said emitter and said detector are mounted to said a fold-over portion.

6. The physiological sensor combination according to claim 5 wherein said substrate defines at least one aperture configured so that said emitter and said detector each align with a corresponding one of said at least one aperture when said fold-over is in a folded position.

7. The physiological sensor combination according to claim 3 further comprising:

a plurality of biopotential sensor pinouts corresponding to said electrodes;

a plurality of optical sensor pinouts corresponding to said emitter and said detector; and

a common connector extending from said substrate, said biopotential sensor pinouts and said optical sensor pinouts each disposed on said common connector.

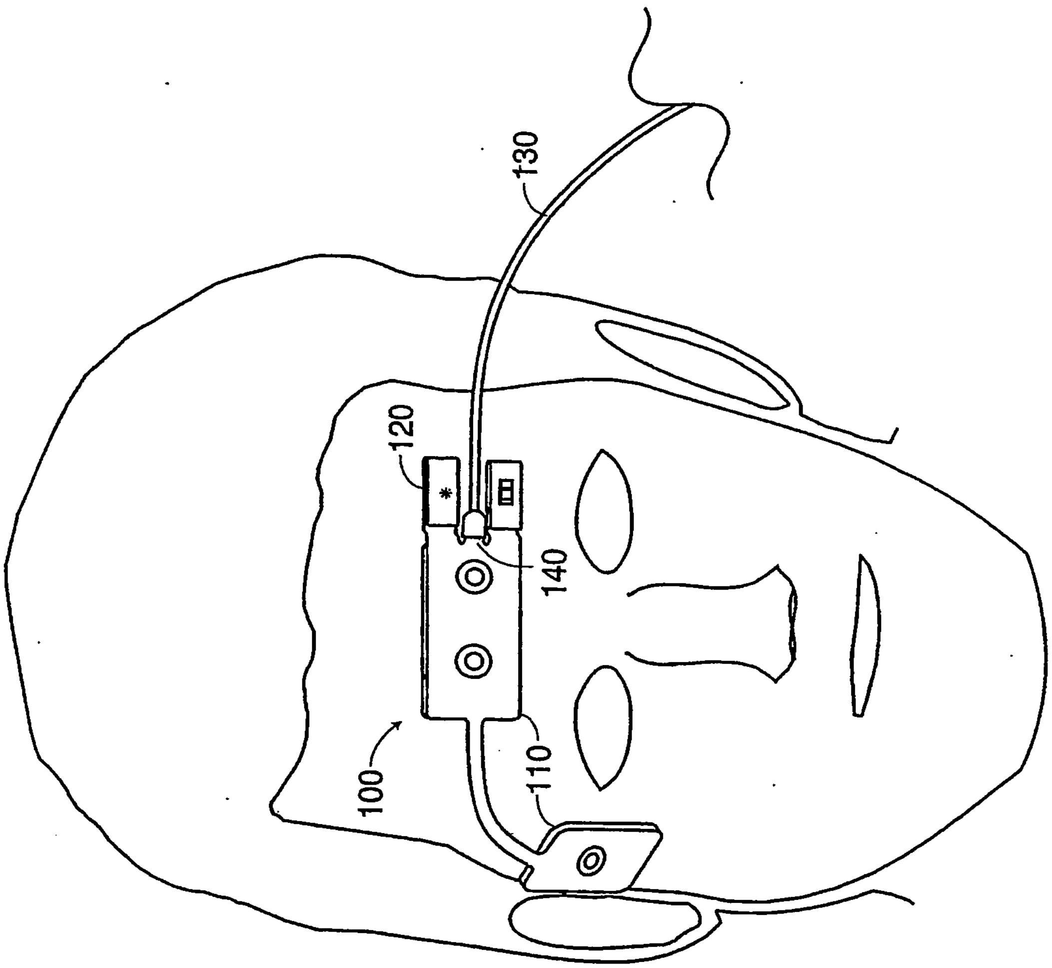
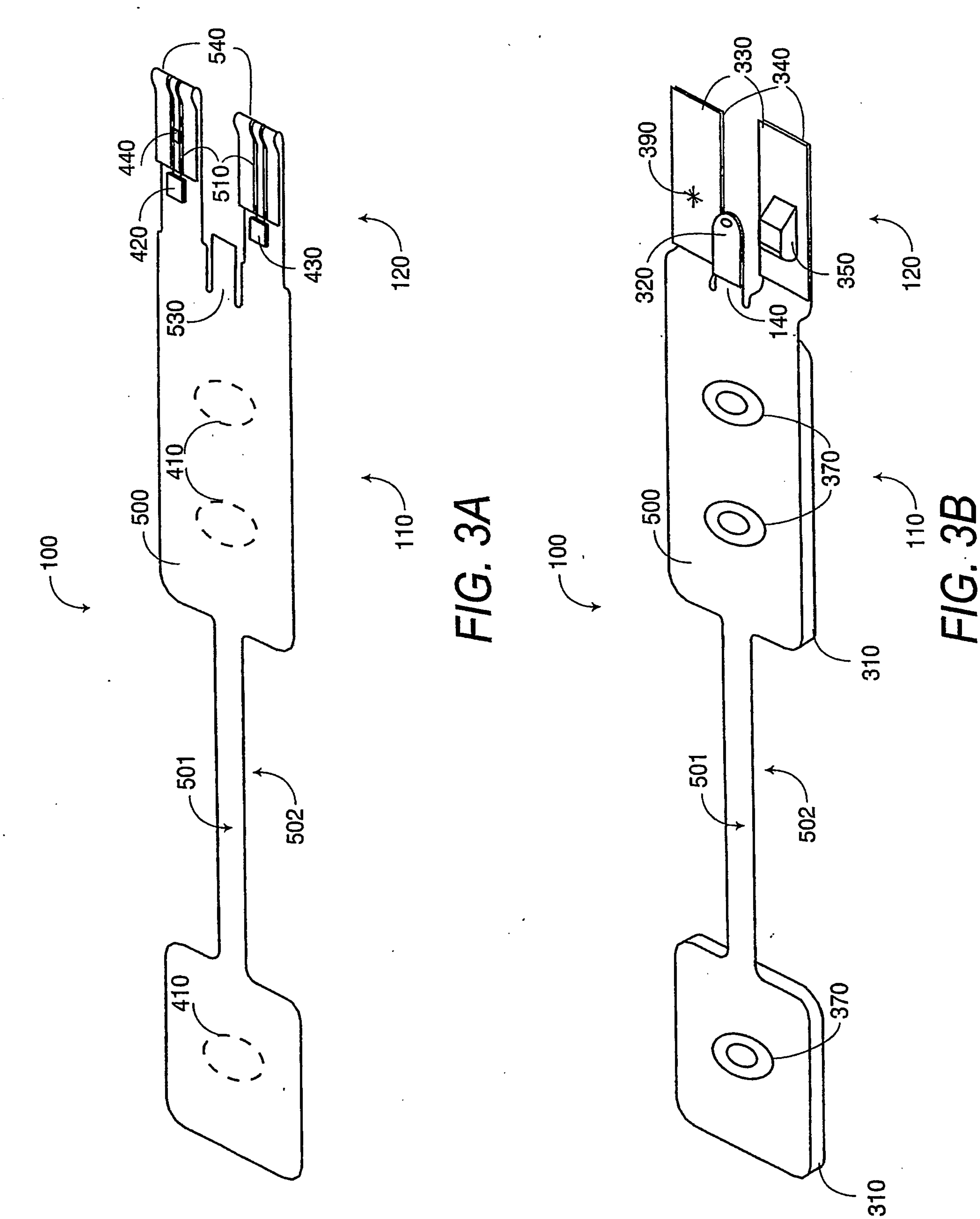


FIG. 1


100
110
120
410
420
430
440
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540
140
310
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350
370
390

FIG. 3A

FIG. 3B

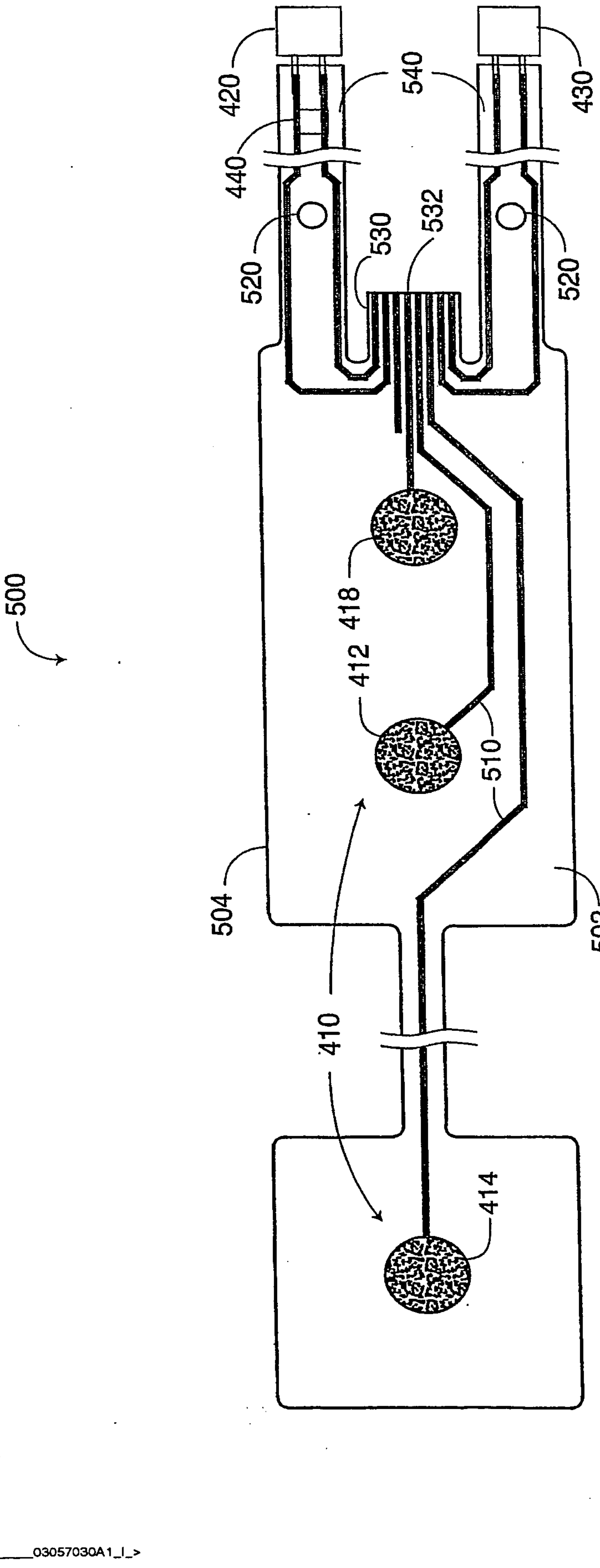

FIG. 5

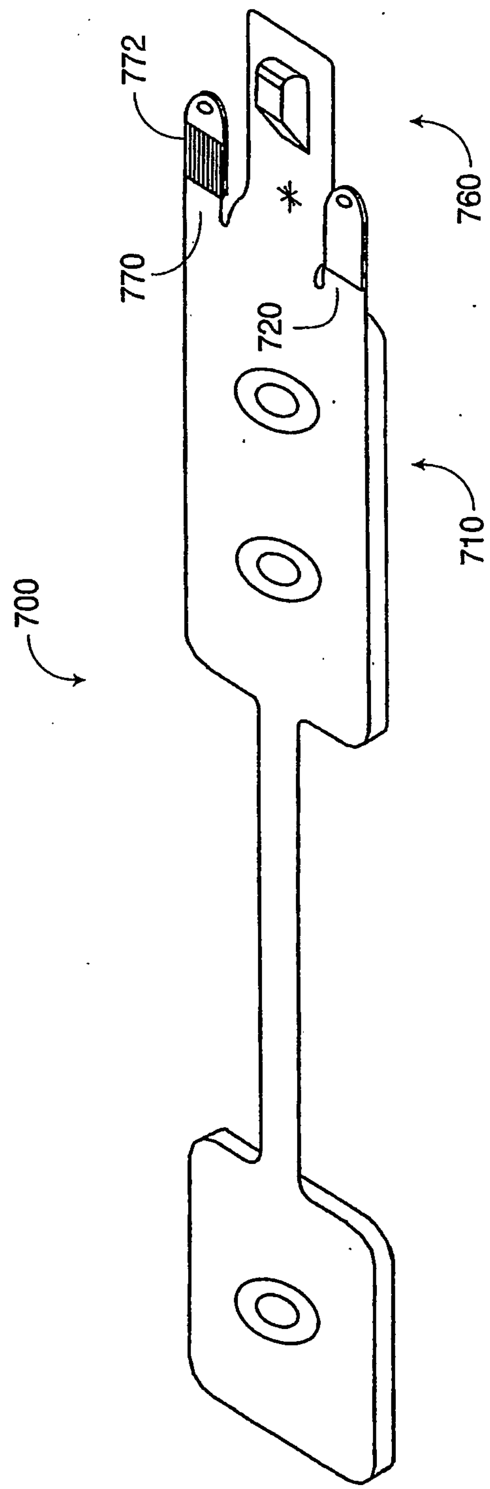

FIG. 7

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 463 620 A (RYBA JAN) 2 January 1992 (1992-01-02) claim 1; figure 1 -----	1